Research Note

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AERIAL PHOTO SCALE-PROTRACTORS FOR MOUNTAINOUS AREAS

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The original aerial photo scale-protractor[1/] developed for Forest Survey in the Central States Region and widely used throughout the country, has been revised for use in the mountainous areas of the West. The improved design gives the device a range of scales more suitable for use on photography having wide variations in scale as well as providing a more readable protractor.

The scale (fig. 1) is used in (a) determining approximate scale of the photo, (b) measuring and laying off distances and angles on the photo, (c) visualizing areas equal to 1/5, 1, 5, and 10 acres at the scale of the photo. It is printed on heavy transparent film and comes in three basic scales:

No. 10--With scales ranging from 1:7,000 through 1:14,500--base scale 1:10,000.

No. 15--With scales ranging from 1:11,000 through 1:19,500--base scale 1:15,000.

No. 20--With scales ranging from 1:16,000 through 1:24,500--base scale 1:20,000.

This range of scales covers elevation differences of 2,000 to 3,000 feet above and below the datum plane of the base scale. Rarely will the interpreter have difficulty in finding a scale to fit any local area.

To include this range of scales it was necessary to use a double row, and to cut some scales to only 20 chains in length. The Representative Fractions (RF) ending in even 1,000's are placed along the

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1/ Karl E. Moessner. The Aerial Photo Scale. Jour. Forestry 46(11): 843-844. November 1948.

_____. The Aerial Photo Scale-Protractor. Central States Forest Experiment Station, Station Note 74. 1953.

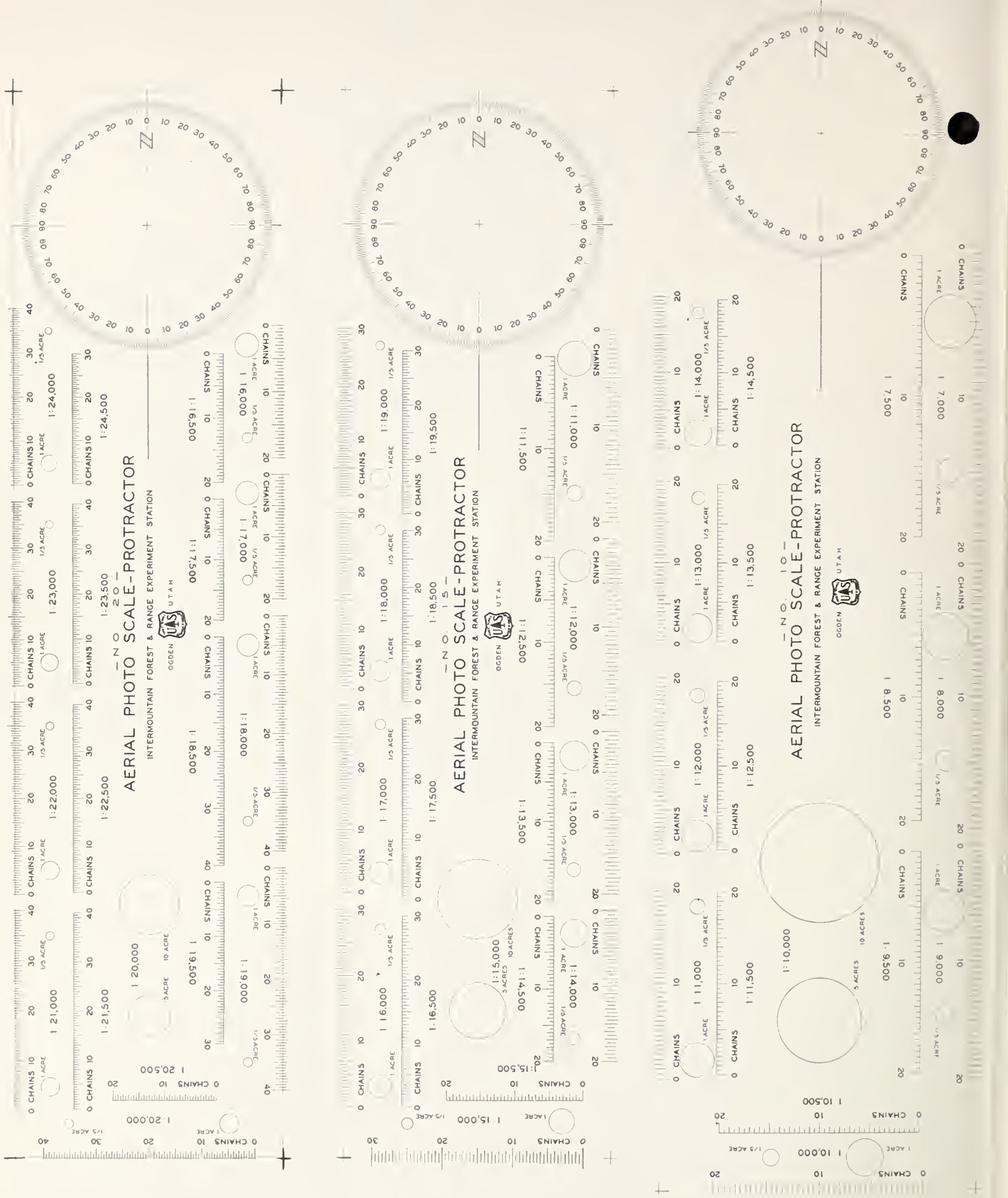

Figure 1.--The photo scale-protractor comes in 3 basic scales: 1:10,000, 1:15,000, and 1:20,000.

outer edge since they are the ones most frequently used by the field personnel. The base scale is at the end and directly below it are the 5-acre and 10-acre plot circles. Only 1/5-acre and 1-acre circles are shown for the other scales.

The protractor is graduated in 4 quadrants. Lines extend in 3 cardinal directions to facilitate laying off angles on the photos.

TO USE THIS SCALE-PROTRACTOR

Determining scale[2/] of photos.--Select 2 intervisible trees or other landmarks, easily identified on your aerial photo and at the same relative elevation (fig. 2). Chain or pace the distance between them. Orient the scale-protractor over your photo and by trial and error select the chain scale which fits best the distance measured on the ground. This gives a local scale, usable at approximately the same elevation. Adjustments of this local scale for differences in elevation can be read from table 1. The Representative Fraction corresponding to this chainage scale as well as the plot size are indicated on the scale-protractor.

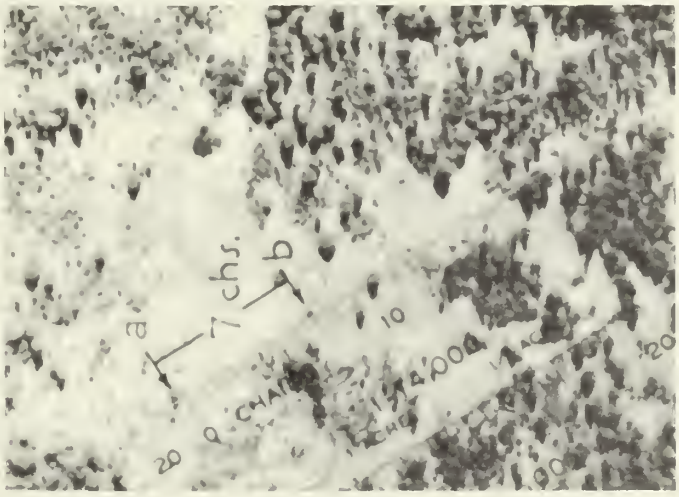

Figure 2.--The measured ground distance of 7 chains between trees (a) and (b) fits the 1:14,000 chain scale.

2/ The procedure described here is one used by field parties in mountains where average scale of photo has little value and local scale varies with relative elevation throughout the photo. Office procedure would require scaling distances from the best available map.

Table 1.--Adjustment of photo scale for elevation difference

Elevation difference from datum	Focal length camera		
	.6875 foot 8.25 inches	.500 foot 6 inches	.437 foot 5.25 inches
	Change in R/F units		
250	400	500	600
500	700	1,000	1,100
750	1,100	1,500	1,700
1,000	1,500	2,000	2,300
1,250	1,800	2,500	2,900
1,500	2,200	3,000	3,400
1,750	2,500	3,500	4,000
2,000	2,900	4,000	4,600
2,250	3,300	4,500	5,100
2,500	3,600	5,000	5,700
2,750	4,000	5,500	6,300
3,000	4,400	6,000	6,900

Scale changes rounded to nearest 100 units.

Note: Determine R/F at selected datum. Above datum plane subtract indicated change from denominator of R/F. Below datum add indicated change.

Measuring angles and reading compass bearings.--Photo flight lines normally run either N-S or E-W but in areas without rectangular surveys and in most mountainous areas cardinal directions are difficult to determine from the photo alone. The following procedure is used with the scale-protractor.

Select 2 intervisible landmarks at approximately the same relative elevation and identifiable both on the ground and on the photos (fig. 3). Read the compass bearing from landmark (a) to (b). On your photos draw base lines (a-b) and a second line from point to be located (c) to landmark (a). Orient the protractor over point (a) with the compass bearing coinciding with line (a-b). Center line of protractor will form a N-S line and the compass bearing from (a) to (c) may be read directly from the protractor.

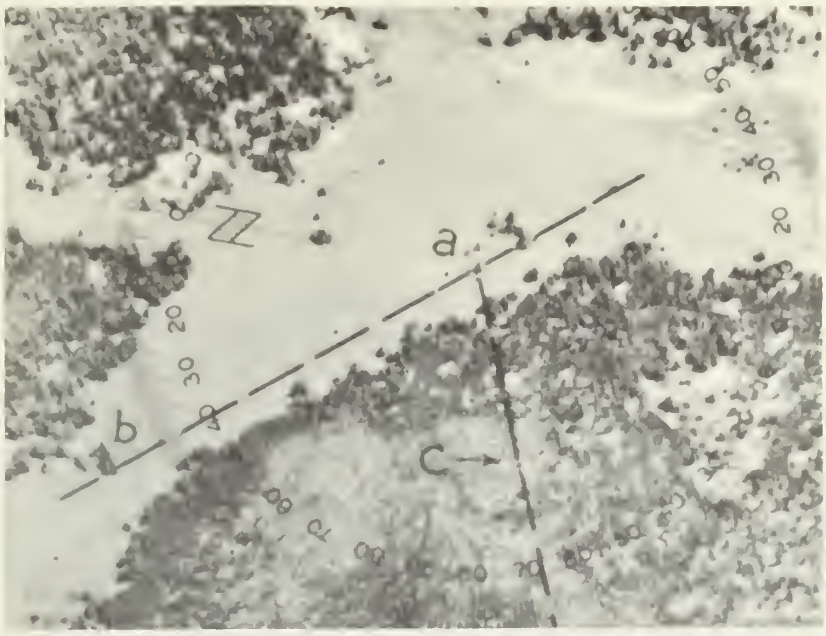

Figure 3.--Compass bearing of line (a-b) is N. 40° W. Protractor is oriented over this line at point (a). Compass bearing of point (c) is then read as S. 67° W.

This method assumes point of departure will be point (a) on the base line. However, point of departure is often a third point (x) which does not lie on base line, but is a point identifiable both on photos and on the ground (fig. 4). Procedure is identical to the first case, except that line (x-c) is extended until it intersects line (a-b). The protractor is then oriented over the point of intersection (p) with compass bearing over (a-b) and the bearing of (x-c) is read. Field crew then proceeds to point (x) by easiest method and starts compass line from this point.

Plotting angles on the photos.--To plot a point at a given angle and distance from the base line marked on photo (fig. 5), orient protractor over point (1) with bearing of the desired angle over line 1-a. Pinpoint the extension of the north line of the protractor (x) on the photo. Connect this point and (1). With your chain scale mark off desired distance and pinpoint point 2.

LIMITATIONS

In mountainous areas, images on vertical aerial photos may be displaced due to relief. The only points which will be in proper relative position will be those on the datum plane used to determine scale. The procedures described above must be used with caution. The accuracy of angles and distances read from the photos will vary according to the amount of elevation change and the distance from photo center. For practical purposes, elevation differences of less than 300 feet can be ignored.

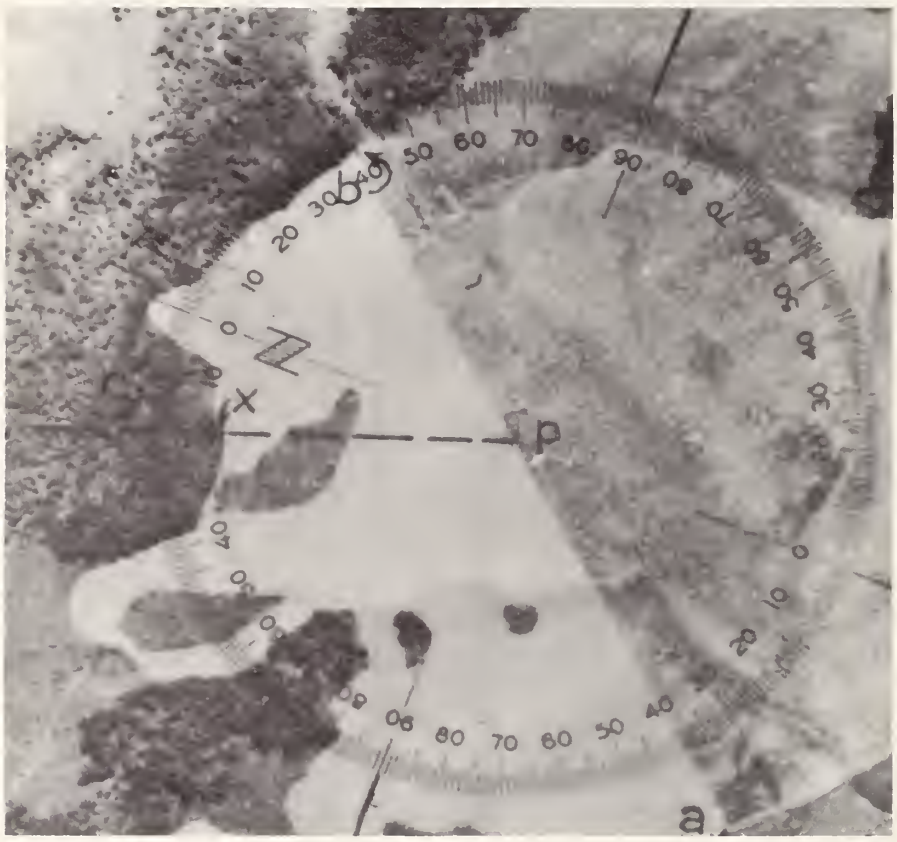

Figure 4.--Compass bearing of field boundary (a-b) is read as N. 40° E. Line from point (c) through tree (x) is extended to intersect (a-b) at (p). Protractor is oriented over (a-b) at (p) and bearing of (x-c) is read as N. 20° W.

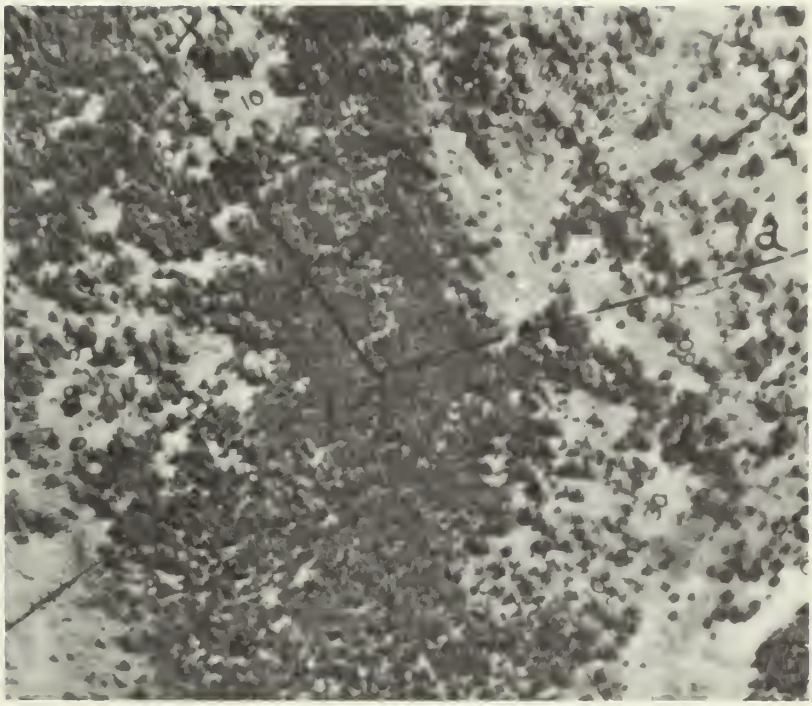

Figure 5.--Protractor is oriented over point 1 using required angle 72°. The north (o) line is marked on photo as (x). Point 2 is laid off along this line by measuring from point 1 with the correct chain scale.